Chapter B4: Economic Value of I&E Losses Based on Benefits Transfer Techniques

This chapter presents an analysis using benefits transfer techniques of economic losses associated with I&E in the Delaware Estuary transition zone. Most of the chapter discusses I&E impacts at the Salem facility because this is the only facility in the transition zone that reported comprehensive I&E data. I&E results from the Salem facility were extrapolated to other in-scope and out-of-scope transition zone facilities (see Section B3-6 of Chapter B3) and summed to obtain total I&E at all transition zone CWIS (see summary of results in Section B3-9 of Chapter B3). Sections B4-1 to B4-6 of this chapter discuss the economic value of I&E at the Salem facility. Section B4-7 discusses the economic value of I&E at all in-scope facilities (Salem, Hope Creek, Edge Moor, and Deepwater), and Section B4-8 discusses economic values for all in-scope and out of scope transition zone CWIS.

CHAPTER CONTENTS

B4-1 Overview of Valuation Approach

I&E at transition zone CWIS affect recreational and commercial fisheries as well as forage species that contribute to the biomass of recreational and commercial species. EPA evaluated all these species groups to capture the total economic impact of I&E at transition zone CWIS.

Recreational fishery impacts are based on benefits transfer methods, applying the results from nonmarket valuation studies. Commercial fishery impacts are based on commodity prices for the individual species. The economic value of forage species losses is determined by estimating the replacement cost of these fish if they were to be restocked with hatchery fish, and by considering the foregone biomass production of forage fish resulting from I&E losses and the consequential foregone production of commercial and recreational species that use the forage species as a prey base. All of these methods are explained in further detail in the Chapters A5 and A9 of Part A of this document.

Many of the I&E-impacted fish species at CWIS sites are harvested both recreationally and commercially. To avoid double-counting the economic impacts of I&E on these species, EPA determined the proportion of total species landings attributable to recreational and commercial fishing, and applied this proportion to the impacted fishery catch. For example, if 30 percent of the landed numbers of one species are harvested commercially at a site, then 30 percent of the estimated catch of I&E-impacted fish are assigned to the increase in commercial landings. The remaining 70 percent of the estimated total landed number of I&E-impacted adult equivalents are assigned to the recreational landings.

The National Marine Fisheries Service (NMFS) provides both recreational and commercial fishery landings data by state. To determine what proportions of total landings per state occur in the recreational or commercial fishery, EPA summed the

landings data for the recreational and commercial fishery, and then divided by each category to get the corresponding percentage. The percentages applied in this analysis are presented in Table B4-1.

As discussed in Chapter A5 of Part A of this document, the yield estimates in Chapter B3 represent the total pounds of foregone yield for both the commercial and recreational catch combined. For the economic valuation discussed in this chapter, total yield was partitioned between commercial and recreational fisheries based on the landings in each fishery, as shown in Table B4-1. Because the economic evaluation of recreational yield is based on numbers of fish rather than pounds, foregone recreational yield was converted to numbers of fish. This conversion was based on the average weight of harvestable fish of each species. Table B4-2 shows these conversions for the Salem impingement data presented in Section B3-7 of Chapter B3 and Table B4-3 displays these data for the entrainment estimates given in Section B3-5. Note that the numbers of foregone recreational fish harvested are typically lower than the numbers of age 1 equivalent losses, since the age of harvest of most fish is greater than age 1.

Table B4-1: Percentages of Total Impacts in the Recreational and Commercial Fisheries of Species at Salem Facility.

Fish Species	Percent Impacts to Recreational Fishery	Percent Impacts to Commercial Fishery
Alewife[a]	0	100
American shad	56	44
Atlantic croaker	10	90
Atlantic menhaden	0	100
Blue crab	4	96
Silverside[a]	0	100
Spot	18	82
Striped bass	97	3
Weakfish	31	69
White perch	42	58
Non-RIS fishery species[b]	26	74

[a] Obtained from NMFS, 2001a and b.
[b] Table B3-1 of Chapter B3 lists non-RIS fishery species. The commercial/recreational split used is an average of the splits for the other species listed above.
Source: PSEG, 1999c, Appendix F.

Table B4-2: Summary of Salem's Mean Annual Impingement of Fishery Species.

Species	Impingement Count (#)	Age 1 Equivalents (#)	Total Catch (#)	Total Yield (lb)	Commercial Catch (#)	Commercial Yield (lb)	Recreational Catch (#)	Recreational Yield (lb)
Alewife	9,560	2,136	44	19	44	19	0	0
American shad	3,658	384	23	94	10	41	13	8
Atlantic croaker	1,082,318	231,830	28,064	47,198	25,258	42,478	2,806	674
Blue crab	589,511	468,661	53,269	14,955	51,138	14,357	2,131	85
Spot	20,111	18,956	5,120	2,123	4,199	1,741	922	55
Striped bass	11,417	5,972	743	8,289	22	249	721	1,149
Weakfish	1,348,531	55,856	8,020	43,913	5,534	30,300	2,486	1,945
White perch	224,902	167,741	318	74	184	43	133	5
Non-RIS fishery species[a]	934,370	215,821	17,895	19,280	13,242	14,267	4,653	716
Total	4,224,378	1,167,358	113,496	135,945	99,632	103,495	13,865	4,638

[a] Table B3-1 of Chapter B3 lists non-RIS species.

Table B4-3: Summary of Salem's Mean Annual Entrainment Results for Fishery Species.

Species	Entrainment Count (#)	Age 1 Equivalents (#)	Total Catch (#)	Total Yield (lb)	Commercial Catch (#)	Commercial Yield (lb)	Recreational Catch (#)	Recreational Yield (lb)
Alewife	1,338,721	1,567	32	14	32	14	0	0
American shad	57,131	70	4	17	2	8	2	8
Atlantic croaker	115,035,206	16,454,185	1,991,879	3,349,863	1,792,691	3,014,877	199,188	287,131
Atlantic menhaden	21,786,584	2,346,168	723,773	1,177,437	723,773	1,177,437	0	0
Silversides	26,001,930	107,867	3,959	43	3,959	43	0	0
Spot	49,187,259	23,848,126	6,441,601	2,670,978	5,282,113	2,190,202	1,159,488	412,094
Striped bass	41,434,832	419,505	52,189	582,257	1,566	17,468	50,624	484,105
Weakfish	104,383,899	1,215,517	174,528	955,624	120,424	659,381	54,104	253,923
White perch	44,044,530	1,211,578	2,295	533	1,331	309	964	192
Non-RIS fishery species[a]	153,969,330	13,879,726	1,150,863	1,239,935	851,639	917,552	299,224	46,055
Total	557,239,422	59,484,307	10,541,123	9,976,701	8,777,529	7,977,290	1,763,594	1,483,508

[a] Table B3-1 of Chapter B3 lists non-RIS species.

B4-2 Economic Value of Average Annual Recreational Fishery Losses at the Salem Facility

B4-2.1 Economic Values for Recreational Losses from Consumer Surplus Literature

There is a large literature that provides willingness-to-pay values for increases in recreational catch rates. These increases in value are benefits to the anglers, and are often referred to by economists as "consumer surplus." For the application of this literature to value I&E impacts, EPA focused on changes in consumer surplus per additional fish caught.

When using values from the existing literature as proxies for the value of a trip or fish at a site not studied, it is important to select values for similar areas and species. Table B4-4 gives a summary of several studies that are closest to Delaware Estuary fisheries in geographic area and relevant species.

McConnell and Strand (1994) estimated fishery values for the mid- and south Atlantic states using data from the National Marine Fisheries Statistical Survey. They created a random utility model of fishing behavior for nine states, the northernmost being New York. In this model they specified four categories of fish: small gamefish (e.g., striped bass), flatfish (e.g., flounder), bottomfish (e.g., weakfish, spot, Atlantic croaker, perch), and big gamefish (e.g., shark). For each fish category, they estimated per angler values for access to marine waters and for an increase in catch rates.

Hicks et al. (1999) used the same method as McConnell and Strand (1994) but estimated values for a day of fishing and an increase in catch rates for the Atlantic states from Virginia north to Maine. Their estimates were generally lower than those of McConnell and Strand (1994) and can serve as a lower bound for the values of fish.

Agnello (1989) estimated one value for increased weakfish catch rates in all the Atlantic states. This study is useful because it values weakfish specifically, but the area considered ranges from Florida to Maine. This large study area may differ from the Delaware Estuary, where weakfish is a very important recreational species.

Norton et al. (1983) estimated the value of the striped bass fishery for the mid-Atlantic coast, including Delaware and New Jersey.

Tudor et al. (2002; see Chapter B5 of this document) estimated willingness-to-pay (WTP) values for increases in recreational catch rates for selected species in Delaware Bay Estuary (values also were derived for the Ohio River and Tampa Bay). The analysis used random utility modeling (RUM) to estimate WTP for an additional fish per trip. These values estimated were not applied in the Salem benefits transfer analysis done here in this chapter, but are discussed and used in Chapter B5, and applied to baseline losses in Chapter B6.

Table B4-4: Selected Valuation Studies for Estimating Changes in Catch Rates.

Authors	Study Location and Year	Item Valued	Value Estimate ($2000)	
McConnell and Strand (1994)	Mid- and south Atlantic coast, anglers targeting specific species, 1988	Catch rate increase of 1 fish per trip for DE and NJ[a]	DE small game fish DE bottom fish NJ small game fish NJ bottom fish	$15.45 $0.13 $9.19 $1.75
Hicks et al. (1999)	Mid-Atlantic coast, 1994	Catch rate increase of 1 fish per trip, from catch rates at all sites, for DE and NJ	DE small game fish DE bottom fish NJ small game fish NJ bottom fish	$3.13 $2.39 $3.49 $2.01
Agnello (1989)	Atlantic coast, 1981	Mean value per fish caught, for the Atlantic coast[b]	Weakfish	$2.72
Norton et al. (1983)	Mid-Atlantic coast, 1980	Catch rate increase of 1 striped bass per trip, for mid-Atlantic	Striped bass	$15.55
Tudor et al. (2002)[c]	Delaware Estuary, 1994-1998	Catch rate increase of 1 fish per trip, for DE	Weakfish Striped bass Bluefish Flounder	$11.50 $18.14 $3.94 $3.92

[a] Value was reported as "two month value per angler for a half fish catch increase per trip." From 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (U.S. DOI, 1997); the average saltwater angler takes 1.5 trips in a 2 month period. Therefore, to convert to a "1 fish per trip" value, EPA divided the 2 month value by 1.5 trips and then multiplied it by 2, assuming the value of a fish was linear.

[b] These values were reported as "consumer surplus for an 20 percent increase in catch rate for all fish." The average catch rate was 4.95 fish per trip, therefore a 20 percent increase in catch is equivalent to 1 more fish.

[c] See Chapter B5 of this document.

EPA used results from these studies (all except Tudor et al., 2002; see Chapter B5 of this document) to create a range of possible consumer surplus values for the recreational fish landings foregone because of impingement and entrainment at Salem.

To estimate a unit value for recreational landings, EPA established a lower and upper value for the recreational species, based on values reported in the studies in Table B4-4. Because the studies in Table B4-4 are geographically specific, EPA created a lower and upper value for Delaware and New Jersey, and then calculated a weighted average value based on the proportion of landings from each state. These values are presented in Table B4-5.

Table B4-5: Average Recreational Value by Species for Delaware and New Jersey, 1990-1998.

Species	State	Percentage Catch	Value/Fish ($2000)		Weighted Average ($2000)	
			Low	High	Low	High
Atlantic croaker	DE	67.4%	$0.13	$2.01		
	NJ	32.6%	$1.75	$2.39	$0.66	$2.27
American shad	DE	50.0%	$0.13	$2.01		
	NJ	50.0%	$1.75	$2.39	$0.94	$2.20
Spot	DE	66.5%	$0.13	$2.01		
	NJ	33.5%	$1.75	$2.39	$0.67	$2.26
Striped bass	DE	9.2%	$3.13			
	NJ	90.8%	$3.49	$15.55[a]	$3.46	$15.55
Weakfish	DE	36.5%	$0.13			
	NJ	63.5%	$1.75	$2.72[b]	$1.16	$2.72
White perch	DE	69.6%	$0.13	$2.01		
	NJ	30.4%	$1.75	$2.39	$0.62	$2.27
Blue crab[c]	DE	-	-	-		
	NJ	-	-	-	$1.25[c]	$4.55[c]
Non-RIS fishery species[d]	DE	-	-	-		
	NJ	-	-	-	$1.25[c]	$4.55[c]

[a] Striped bass high value taken from Norton et al. (1983) and is the same for both states.
[b] Weakfish high value taken from Agnello (1989) and is the same for both states.
[c] Recreational catch and value information has not been located, thus EPA used an equally weighted average value of the other species listed in the table.
[d] Recreational values used are averaged from all other species' values. See Table B3-1 of Chapter B3 for list of non-RIS fishery species.
Source: NMFS, 2001b.

B4-2.2 Average Annual I&E Losses of Recreational Yield at Salem and Economic Value of Losses

EPA estimated the economic value of I&E impacts to recreational fisheries using the I&E estimates presented in Tables B4-2 and B4-3 and the economic values in Table B4-5. Results are displayed in Tables B4-6 and B4-7, for impingement and entrainment, respectively. The estimated total loss to recreational fisheries ranges from $16,400 to $57,600 per year for impingement, and from $1,523,400 to $5,373,000 per year for entrainment.

Table B4-6: Mean Annual Impingement of Recreational Fishery Species at Salem and Associated Economic Values Based on the Impingement Data Summarized in Table B4-2 and Discussed in Section B3-7 of Chapter B3.

Species	Loss to Recreational Catch from Impingement (number of fish)	Recreational Value/Fish[a]		Annual Loss in Recreational Value from Impingement ($2000)	
		Low	High	Low	High
American shad	13	$0.94	$2.20	$12	$28
Atlantic croaker	2,806	$0.66	$2.27	$1,847	$6,360
Atlantic menhaden	NA			NA	NA
Blue crab[b]	2,131	$1.25	$4.55	$2,667	$9,686
Silversides	NA			NA	NA
Spot	922	$0.67	$2.26	$620	$2,085
Striped bass	721	$3.46	$15.55	$2,491	$11,206
Weakfish	2,486	$1.16	$2.72	$2,881	$6,762
White perch	133	$0.62	$2.27	$83	$304
Non-RIS fishery species[c]	4,653	$1.25	$4.55	$5,816	$21,170
Total	13,865			$16,417	$57,601

NA = data not available.

[a] Recreational values stated are weighted averages, as calculated in Table B4-5, and values listed here are rounded to two digits, but are not rounded in the calculations.

[b] Recreational catch and value information has not been located, thus EPA used an equally weighted average value of the other species listed in the table.

[c] Recreational values used are averaged from all other species' values. See Table B3-1 of Chapter B3 for list of non-RIS fishery species.

Fri Feb01 16:59:11 MST 2002; Table B: recreational losses and value for selected species; Plant: salem100.benefits, type: I Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableB.rec.losses.salem100.benefits.I.csv

Table B4-7: Mean Annual Entrainment of Recreational Fishery Species at Salem and Associated Economic Values Based on the Entrainment Presented in Table B4-3 and Discussed in Section B3-5 of Chapter B3.

Species	Loss to Recreational Catch from Entrainment (number of fish)	Recreational Value/Fish[a]		Annual Loss in Recreational Value from Entrainment ($2000)	
		Low	High	Low	High
American shad	2	$0.94	$2.20	$2	$5
Atlantic croaker	199,188	$0.66	$2.27	$131,090	$451,384
Spot	1,159,488	$0.67	$2.26	$779,988	$2,623,574
Striped bass	50,624	$3.46	$15.55	$175,000	$787,199
Weakfish	54,104	$1.16	$2.72	$62,690	$147,162
White perch	964	$0.62	$2.27	$600	$2,193
Non-RIS fishery species[b]	299,224	$1.25	$4.55	$374,031	$1,361,471
Total	1,763,594			$1,523,400	$5,372,987

[a] Recreational values stated are weighted averages, as calculated in Table B4-5, and values listed here are rounded to two digits, but are not rounded in the calculations. Thus, annual losses that are reported here may differ from calculations made with the rounded values.

[b] Recreational values used are averaged from all other species' values. See Table B3-1 of Chapter B3 for list of non-RIS fishery species.

Fri Feb 01 16:59:27 MST 2002; Table B: recreational losses and value for selected species; Plant: salem100.benefits; type: E Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableB.rec.losses.salem100.benefits.E.csv

B4-3 Economic Value of Average Annual Commercial Fishery Losses at the Salem Facility

B4-3.1 Average Annual I&E Losses of Commercial Yield at Salem and Economic Value of Losses

I&E losses to commercial catch (pounds) are presented in Tables B4-2 (for impingement) and B4-3 (for entrainment) based on the commercial and recreational splits listed in Table B4-1. EPA estimates of the economic value of these losses are displayed in Tables B4-8 and B4-9 for impingement and entrainment, respectively. Market values per pound are listed as well as the total market losses experienced by the commercial fishery. Values for commercial fishing are relatively straightforward because commercially caught fish are a commodity with a market price. The estimates of market loss to the commercial fisheries are $98,000 per year for impingement, and $5,814,700 per year for entrainment.

Table B4-8: Mean Annual Impingement of Commercial Fishery Species at Salem and Associated Economic Values Based on the Impingement Data Presented in Table B4-2 and Discussed in Section B3-7 of Chapter B3.

Species	Loss to Commercial Catch from Impingement (lb of fish)	Commercial Value (lb of fish)[b]	Annual Loss in Commercial Value from Impingement ($2000)
Alewife	19	$0.11	$2
American shad	41	$0.72	$30
Atlantic croaker	42,478	$0.70	$29,735
Atlantic menhaden	NA	$0.07	NA
Blue crab	14,357	$1.02	$14,644
Spot	1,741	$0.85	$1,480
Striped bass	249	$3.18	$791
Weakfish	30,300	$1.24	$37,572
White perch	43	$1.20	$51
Non-RIS fishery species[a]	14,267	$0.96	$13,697
Total	103,495		$98,001

NA = data not available.

[a] Commercial value used is the average commercial value for the other species. See Table B3-1 of Chapter B3 for list of non-RIS fishery species.

[b] Values are rounded to two decimal places here for listing but not in the calculations.

Fri Feb 01 16:59:27 MST 2002 ; TableC: commercial losses and value for selected species; Plant: salem100.benefits; type: I Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableC.comm.losses.salem100.benefits.I.csv

Table B4-9: Mean Annual Entrainment of Commercial Fishery Species at Salem and Associated Economic Values Based on the Entrainment Data Presented in Table B4-3 and Discussed in Section B3-5 of Chapter B3.

Species	Loss to Commercial Catch from Entrainment (lb of fish)	Commercial Value (lb of fish)[b]	Annual Loss in Commercial Value from Entrainment ($2000)
Alewife	14	$0.11	$2
American shad	7	$0.72	$5
Atlantic croaker	3,014,877	$0.70	$2,110,414
Atlantic menhaden	1,177,437	$0.07	$88,184
Silversides	43	$0.46	$20
Spot	2,190,202	$0.85	$1,861,672
Striped bass	17,468	$3.18	$55,547
Weakfish	659,381	$1.24	$817,632
White perch	309	$1.20	$371
Non-RIS fishery species[a]	917,552	$0.96	$880,850
Total	7,977,290		$5,814,696

[a] Commercial value used is the average commercial value for the other species. See Table B3-1 of Chapter B3 for list of non-RIS fishery species.
[b] Values are rounded to two decimal places here for listing but not in the calculations.
Fri Feb 01 16:59:30 MST 2002 ; TableC: commercial losses and value for selected species; Plant: salem100.benefits; type: E Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableC.comm.losses.salem100.benefits.E.csv

B4-3.2 Economic Impacts of Commercial Landings Losses

The previous section expresses changes to commercial activity as changes in dockside market prices. However, to determine the total economic impact from changes to the commercial fishery, EPA also determined the losses experienced by producers wholesalers, retailers, and consumers.

The total social benefits (economic surplus) are greater than the increase in dockside landings, because the increased landings by commercial fishermen contribute to economic surplus in each of a multi-tiered set of markets for commercial fish. The total economic surplus impact thus is valued by examining the multi-tiered markets through which the landed fish are sold, according to the methods and data detailed in Chapter A9.

The first step of the analysis involves a fishery-based assessment of I&E-related changes in commercial landings (pounds of commercial species as sold dockside by commercial harvesters). The results of this dockside landings value step are described above. The next steps then entail tracking the anticipated additional economic surplus generated as the landed fish pass from dockside transactions to other wholesalers, retailers and, ultimately, consumers. The resulting total economic surplus measures include producer surplus to the watermen who harvest the fish, as well as the rents and consumer surplus that accrue to buyers and sellers in the sequence of market transactions that apply in the commercial fishery context.

To estimate producer surplus from the landings values, EPA relied on empirical results from various researchers that can be used to infer producer surplus for watermen based on gross revenues (landings times wholesale price). The economic literature (Huppert, 1990; Rettig and McCarl, 1985) suggests that producer surplus values for commercial fishing ranges from 50 to 90 percent of the market value. In assessments of Great Lakes fisheries, an estimate of approximately 40% has been derived as the relationship between gross revenues and the surplus of commercial fishermen (Cleland and Bishop, 1984, Bishop, personal communication, 2002). For the purposes of this study, EPA believes producer surplus to watermen is probably in the range of 40% to 70% of dockside landings values.

Producer surplus is one portion of the total economic surplus impacted by increased commercial stocks — the total benefits are comprised of the economic surplus to producers, wholesalers, processors, retailers, and consumers. Primary empirical research deriving “multi-market” welfare measures for commercial fisheries have estimated that surplus accruing to commercial anglers amount to approximately 22% of the total surplus accruing to watermen, retailers and consumers

combined (Norton et al., 1983; Holt and Bishop, 2002). Thus, total economic surplus across the relevant commercial fisheries multi-tiered markets can be estimated as approximately 4.5 times greater than producer surplus alone (given that producer surplus is roughly 22% of the total surplus generated). This relationship is applied in the case studies to estimate total surplus from the projected changes in commercial landings.

Applying this method, estimates of the baseline economic loss to the commercial fisheries ranges from $178,200 to $311,800 per year for impingement, and from $10,572,200 to $18,501,300 per year for entrainment for the Salem facility.

B4-4 Economic Value of Forage Fish Losses

Many fish species affected by I&E are not commercially or recreationally fished. For the purposes in this study, EPA referred to these species as forage fish. Forage fish are species that are prey for other species and are important components of aquatic food webs. Table B4-10 summarizes impingement losses of forage species at Salem and Table B4-11 summarizes entrainment losses. The following sections discuss the economic valuation of these losses using two alternative valuation methods.

Table B4-10: Summary of Salem's Mean Annual Impingement of Forage Species.

Species	Impingement Count (#)	Age 1 Equivalents (#)	Production Foregone (lb)
Bay anchovy	592,248	525,130	500
Blueback herring	83,997	12,802	4,269
Non-RIS Forage[a]	1,733,222	1,480,270	1,288
Total	2,409,467	2,018,201	6,057

[a] Table B3-1 of Chapter B3 lists non-RIS species.

Table B4-11: Summary of Salem's Mean Annual Entrainment of Forage Species.

Species	Entrainment Count (#)	Age 1 Equivalents (#)	Production Foregone (lb)
Bay anchovy	13,129,437,661	290,409,647	7,043,992
Blueback herring	5,563,808	6,745	15,361
Non-RIS forage[a]	967,814,719	6,423,701	1,255,798
Forage sum	14,102,816,188	296,840,093	8,315,151

[a] Table B3-1 of Chapter B3 lists non-RIS species.

Replacement cost of fish

The replacement value of fish can be used in several instances. First, if a fish kill of a fishery species is mitigated by stocking of hatchery fish, then losses to commercial and recreational fisheries would be reduced, but fish replacement costs would still be incurred and should be accounted for. Second, if the fish are not caught in the commercial or recreational fishery, but are important as forage or bait, the replacement value can be used as a lower bound estimate of their value (it is a lower bound because it would not consider how reduction in their stock may affect other species' stocks). Third, where there are not enough data to allow calculation of the value of losses to the recreational and commercial fisheries, replacement cost can be used as a proxy for lost fishery values.

The cost of replacing forage fish lost to I&E has two main components. The first component is the cost of raising the replacement fish. Table B4-12 displays the replacement costs of two of the forage fish species known to be impinged or entrained at Salem. The costs are average costs to fish hatcheries across North America to produce the fish for stocking. The second component of replacement cost is the transportation cost, which includes costs associated with vehicles, personnel, fuel, water, chemicals, containers, and nets. The AFS (1993) estimates these costs at approximately $1.13 per mile, but does not indicate how many fish (or how many pounds of fish) are transported for this price. Lacking relevant data, EPA does not include the transportation costs in this valuation approach.

Table B4-12 also presents the annual average replacement cost for impinged and entrained forage species at Salem. The value of these losses using the replacement cost method is $2,246 per year for impingement and $130,224 per year for entrainment.

Table B4-12: Replacement Costs for Losses of Forage Fish Species at the Salem Facility.[a]

Species	Hatchery Costs ($/lb)	Annual Cost of Replacing Forage Losses ($2000)	
		Impingement	Entrainment
Bay anchovy (all U.S. regions)	$0.11	$220	$121,838
Blueback herring (all U.S. regions)	$0.52	$106	$56
Non-RIS forage species[b]	$0.34	$1,920	$8,330
Total		$2,246	$130,224

[a] Values are from AFS (1993). These values were inflated to $2000 from $1989, but this could be imprecise for current fish rearing and stocking costs.
[b] This is an average value for all species listed in AFS (1993). See Table B3-1 of Chapter B3 for list of non-RIS forage species.

Production foregone value of forage fish

This approach considers the foregone production of commercial and recreational fishery species resulting from I&E of forage species based on estimates of trophic transfer efficiency, as discussed in Chapter A5 of Part A of this document. The economic valuation of forage losses is based on the dollar value of the foregone fishery yield resulting from these losses. Table B4-13 displays the results for impingement of forage species at Salem and B4-14 displays results for entrainment. The values listed are obtained by converting the forage species into species that may be commercially or recreationally valued. The values range from $30 to $80 per year for impingement and from $48,500 to $129,900 per year for entrainment.

Table B4-13: Mean Annual Value of Production Foregone of Selected Fishery Species Resulting from Impingement of Forage Species at Salem Based on the Impingement Data Presented in Table B4-10 and Discussed in Section B3-7 of Chapter B3.

Species	Annual Loss in Production Foregone Value from Impingement of Forage Species ($2000)	
	Low	High
Atlantic croaker	$5	$9
Blue crab	$4	$9
Spot	$4	$8
Striped bass	$3	$11
Weakfish	$8	$14
White perch	$0	$1
Non-RIS fishery species[a]	$5	$11
Total	$30	$63

[a] See Table B3-1 of Chapter B3 for list of non-RIS fishery species.
Fri Feb 01 16:59:21 MST 2002; Table D: loss in selected forage species; Plant: salem100.benefits; type: I Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableD.forage.eco.ter.repl.salem100.benefits.I.csv

Table B4-14: Mean Annual Value of Production Foregone of Selected Fishery Species Resulting from Entrainment of Forage Species at Salem Based on the Entrainment Data Presented in Table B4-11 and Discussed in Section B3-5 of Chapter B3.

Species	Annual Loss in Production Foregone Value from Entrainment of Forage Species ($2000)	
	Low	High
Alewife	$18	$31
American shad	$161	$299
Atlantic croaker	$4,122	$7,444
Atlantic menhaden	$6,944	$12,152
Silversides	$25,247	$44,182
Spot	$10,908	$22,385
Striped bass	$909	$3,174
Weakfish	$6,705	$11,896
White perch	$451	$1,193
Non-RIS fishery species[a]	$398	$839
Total	$55,862	$103,595

[a] See Table B3-1 of Chapter B3 for list of non-RIS fishery species.
Fri Feb 01 16:59:33 MST 2002; Table D: loss in selected forage species; Plant: salem100.benefits; type: E Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableD.forage.eco.ter.repl.salem100.benefits.E.csv

B4-5 Nonuse Values

Recreational consumer surplus and commercial impacts are only part of the total losses that the public realizes from I&E impacts on fisheries. Nonuse or passive use impacts arise when individuals value environmental changes apart from any past, present, or anticipated future use of the resource in question. Such passive use values have been categorized in several ways in the economic literature, typically embracing the concepts of existence (stewardship) and bequest (intergenerational equity) motives. Using a "rule of thumb" that nonuse impacts are at least equivalent to 50 percent of the recreational use impact (see Chapter A9 for further discussion), EPA estimated nonuse values for baseline losses at Salem to range from $8,200 to $28,800 per year for impingement and from $761,700 to $2,686,500 per year for entrainment.

B4-6 Summary of Mean Annual Value of Economic Losses at Salem

Table B4-15 summarizes the estimated current annual I&E at the Salem facility and the economic valuation of these losses. Estimated total impacts range from $0.2 million to $0.4 million per year for impingement and from $12.9 million to $26.7 million per year for entrainment.

Table B4-15: Summary of Economic Valuation of Mean Annual I&E at Salem Facility ($2000).

		Impingement	Entrainment	Total	Percent of Impingement Impacts[a]	Percent of Entrainment Impacts[a]
Commercial: Total Surplus (Direct Use, Market)	Low	$178,184	$10,572,175	$10,750,359	81.2%	73.4%
	High	$311,822	$18,501,306	$18,813,128		
Recreational (Direct Use, Nonmarket)	Low	$16,417	$1,523,400	$1,539,816	12.3%	17.4%
	High	$57,601	$5,372,987	$5,430,588		
Nonuse (Passive Use, Nonmarket)	Low	$8,208	$761,700	$769,908	6.1%	8.7%
	High	$28,800	$2,686,493	$2,715,294		
Forage (Indirect Use, Nonmarket)					0.4%	0.5%
Production Foregone	Low	$30	$55,862	$55,893		
	High	$63	$103,595	$103,659		
Replacement		$2,246	$130,224	$132,470		
Total (Com + Rec + Nonuse + Forage)[b]	Low	$202,839	$12,913,137	$13,115,976	100%	100%
	High	$400,469	$26,691,011	$27,091,480		

[a] Midpoints of the ranges are used to calculate percentages.
[b] In calculating the total low values, the lower of the two forage valuation methods (production foregone and replacement) was used and to calculate the total high values, the higher of the two forage valuation methods was used.
Fri Feb 01 16:59:39 MST 2002 ; TableE.summary; Plant: salem100.benefits ; Pathname: P:/Intake/Delaware/Del-Science/scodes/tables.output.benefits.baseline/TableE.summary.salem100.benefits.csv

B4-7 Total Economic Damages for Generating Facilities Regulated Under Phase 2

I&E results for the Salem facility were extrapolated to other in-scope transition zone facilities (see Section B3-6 of Chapter B3) and summed to obtain total losses from I&E at all in-scope transition zone CWIS. Table B4-16 displays estimates of the economic value of these losses. Results range from $0.4 million to $0.8 million per year for impingement and from $20.0 million to $41.4 million per year for entrainment.

Table B4-16: EPA's Estimates of Average Annual Economic Losses at In-scope CWIS of the Transition Zone of the Delaware Estuary ($2000).

Facility	Impingement Losses		Entrainment Losses		Total	
	Low	High	Low	High	Low	High
Salem[a]	$202,839	$400,469	$12,913,137	$26,691,011	$13,115,976	$27,091,480
Hope Creek	$13,963	$28,920	$464,933	$961,000	$478,896	$989,921
Edge Moor	$176,114	$364,771	$5,864,154	$12,121,005	$6,040,268	$12,485,776
Deepwater (w/o Chambers Cogen)	$23,557	$48,792	$784,387	$1,621,301	$807,944	$1,670,092
Total	$416,473	$842,952	$20,026,611	$41,394,317	$20,443,084	$42,237,269

[a] Based on EPA's estimate of Salem's current I&E assuming no impingement or entrainment survival, as discussed in Section B3-7 of Chapter B3. Salem's data for 1996 was not included because the facility was shut down much of the year.
Wed Feb 06 13:15:50 MST 2002 extrapolation.summary ; salem100.extrapolation
P:/INTAKE/Delaware/Del-Science/scodes/extrapolation.benefits.facilities/extrapolation.summarynew.csv

B4-8 Total Economic Damages for All Transition Zone CWIS

Table B4-17 displays EPA's estimates of the mean annual economic losses for all transition zone CWIS (both in scope and out of scope of the proposed rule). Results for these facilities together range from $0.5 million to $1.1 million per year for impingement and from $23.4 million to $48.5 million per year for entrainment.

Table B4-17: EPA's Estimates of Average Annual Economic Losses at All CWIS of the Transition Zone of the Delaware Estuary ($2000).

Facility	Impingement Losses		Entrainment Losses		Total	
	Low	High	Low	High	Low	High
Salem[a]	$202,839	$400,469	$12,913,137	$26,691,011	$13,115,976	$27,091,480
Hope Creek	$13,963	$28,920	$464,933	$961,000	$478,896	$989,921
Dupont	$1,576	$3,265	$52,492	$108,500	$54,069	$111,765
Edge Moor	$176,114	$364,771	$5,864,154	$12,121,005	$6,040,268	$12,485,776
Delaware City Refinery	$81,976	$169,791	$2,729,606	$5,642,002	$2,811,583	$5,811,793
Deepwater (w/o Chambers Cogen)	$23,557	$48,792	$784,387	$1,621,301	$807,944	$1,670,092
Chambers Cogen	$8,333	$17,259	$277,460	$573,500	$285,793	$590,759
Gen Chem Corporation	$7,635	$15,813	$254,213	$525,450	$261,848	$541,263
SPI Polyols	$1,126	$2,332	$37,495	$77,500	$38,621	$79,832
Sun Refining	$1,351	$2,799	$44,994	$93,000	$46,345	$95,799
Logan Generating Co	$450	$933	$14,998	$31,000	$15,448	$31,933
Hay Road	$360	$746	$11,998	$24,800	$12,359	$25,546
Total	$519,282	$1,055,891	$23,449,867	$48,470,070	$23,969,149	$49,525,961

[a] Based on EPA's estimate of Salem's current I&E assuming no impingement or entrainment survival, as discussed in Section B3-7 of Chapter B3. Salem's data for 1996 was not included because the facility was shut down much of the year.
Wed Feb 06 13:09:58 MST 2002 extrapolation.summary ; salem100.extrapolation
P:/INTAKE/Delaware/Del-Science/scodes/extrapolation.baseline.facilities/extrapolation.summarynew.csv